



## Macquarie Marshes Ramsar site

*Ecological character description  
Macquarie Marshes Nature Reserve and U-block components*

## Disclaimer

The Office of Environment and Heritage NSW (OEH) has compiled this document in good faith, exercising all due care and attention. OEH does not accept responsibility for any inaccurate or incomplete information supplied by third parties. No representation is made about the accuracy, completeness or suitability of the information in this publication for any particular purpose. Readers should seek appropriate advice about the suitability of the information to their needs.

The views and opinions expressed in this publication are those of the authors and do not necessarily reflect those of the NSW Government, the Australian Government or the Minister for Sustainability, Environment, Water, Population and Communities or the NSW Minister for the Environment, or the Administrative Authority for Ramsar in Australia.

This information does not create a policy position to be applied in statutory decision-making. Further it does not provide assessment of any particular action within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999*, nor replace the role of the Minister or his delegate in making an informed decision on any action.

This report is not a substitute for professional advice, rather it is intended to inform professional opinion by providing the authors' assessment of available evidence on change in ecological character. This information is provided without prejudice to any final decision by the Administrative Authority for Ramsar in Australia on change in ecological character in accordance with the requirements of Article 3.2 of the Ramsar Convention. Users should obtain any appropriate professional advice relevant to their particular circumstances.

## Acknowledgements

This document has been compiled with the help of many people in NSW Government agencies, and other people with expertise in ecology, hydrology and geomorphology. Those people include Barry Lamph, Dr Kim Jenkins (UNSW), Jo Smith (ecological consultant), Prof Richard Kingsford (UNSW), Dr Silke Nebel (UNSW), Kate Brandis (UNSW), Dr Kerry Lee Rogers (OEH), Bill Johnson (MDBA), Dr Timothy Ralph (Macquarie University), Alison Curtin (OEH), Debbie Love (OEH), Sharon Bowen (OEH) and Rob Smith (OEH).

Funding was provided by the NSW Department of Environment and Climate Change (now Office of Environment and Heritage) and the Commonwealth Department of the Environment, Water, Heritage and the Arts (now Department of Sustainability, Environment, Water, Population and Communities).

Symbols for conceptual models are courtesy of the Integration and Application Network ([ian.umces.edu/symbols](http://ian.umces.edu/symbols)), University of Maryland Center for Environmental Science.

### Cover photos (clockwise from main photo)

River red gum, northern Macquarie Marshes Nature Reserve (©OEH)

Green tree frog (Bill Johnson, ©OEH)

Reed bed and red gums, northern Macquarie Marshes Nature Reserve (Jeff Hillan, ©OEH)

Wavy marsh wort (Bill Johnson, ©OEH)

© State of NSW, Office of Environment and Heritage, Department of Premier and Cabinet.

The Office of Environment and Heritage and the State of NSW are pleased to allow this material to be reproduced, for educational or non-commercial use, in whole or in part, provided the meaning is unchanged and its source, publisher and authorship are acknowledged. Specific permission is required for the reproduction of photographs and other images.

Published by:

Office of Environment and Heritage  
NSW Department of Premier and Cabinet  
59–61 Goulburn Street, Sydney  
PO Box A290, Sydney South, NSW 1232

Phone: (02) 9995 5000 (switchboard)

131 555 (environment information and publications requests)

1300 361 967 (national parks, climate change and energy efficiency  
information and publications requests)

Fax: (02) 9995 5999

TTY: (02) 9211 4723

Email: [info@environment.nsw.gov.au](mailto:info@environment.nsw.gov.au)

Website: [www.environment.nsw.gov.au](http://www.environment.nsw.gov.au)

ISBN 978 1 74293 703 8

OEH 2012/0517

July 2012

Printed on recycled paper

# Contents

Summary	iii
1 Introduction	1
1.1 Site details	1
1.2 Purpose of the ecological character description	3
1.3 Relevant treaties, legislation and policies	4
2 Macquarie Marshes Ramsar site	6
2.1 Location	6
2.2 Ramsar criteria	11
2.3 Macquarie Marshes Nature Reserve wetland types in 1986	16
3 Macquarie Marshes Nature Reserve ecosystem components and processes in 1986	20
3.1 Soils	20
3.2 Physiochemical – water	20
3.3 Wetland vegetation	21
3.4 Aquatic invertebrates	24
3.5 Fish	28
3.6 Frogs	29
3.7 Reptiles	30
3.8 Birds	30
3.9 Mammals	37
3.10 Climate	38
3.11 Geomorphology	39
3.12 Hydrology – water distribution	41
3.13 Hydrology – flow regime	43
3.14 Hydrology – groundwater	46
3.15 Energy and nutrient cycling	47
4 Ecosystem benefits and services	48
5 Critical ecosystem components, processes, benefits and services	52
5.1 Wetland types and vegetation	52
5.2 Aquatic ecological community	52
5.3 Birds	55
5.4 Provisioning service – primary production	55
5.5 Supporting service – threatened species and communities	55
6 Macquarie Marshes conceptual models	57
7 Limits of acceptable change	61

8	Threats to the Macquarie Marshes	70
8.1	Current water management – water availability	71
8.2	Current water management – water allocation	71
8.3	Current water management – river regulation	72
8.4	Water management structures – river and floodplain	72
8.5	Water management structures – Burrendong dam	73
8.6	Increasing salinity	74
8.7	Clearing	75
8.8	Fire management	75
8.9	Pest management	76
8.10	Climate change	76
8.11	Lack of understanding of complex systems	77
9	Changes since Ramsar listing	78
9.1	Northern section of the Macquarie Marshes Nature Reserve component of the Macquarie Marshes Ramsar site	78
9.2	Southern section of the Macquarie Marshes Nature Reserve component of the Macquarie Marshes Ramsar site	82
9.3	U-block component of the Macquarie Marshes Ramsar site	84
9.4	Fish	85
9.5	Aquatic invertebrates	86
9.6	Hydrological change – flow regime	87
9.7	Geomorphological change	89
9.8	Waterbird breeding	89
9.9	Meeting Ramsar criteria in 2010	89
9.10	Changes to the Ramsar site boundary and area	92
10	Knowledge gaps	93
11	Identifying Macquarie Marshes Nature Reserve monitoring needs	96
12	Communication, education, participation and awareness (CEPA)	98
	Abbreviations	100
	Glossary	101
	References	105
	Appendix 1: Plant species recorded in the Macquarie Marshes Nature Reserve	117
	Appendix 2: Animal species recorded in the Macquarie Marshes Nature Reserve	128
	Appendix 3: Curricula vitae of authors	142



## Summary

This ecological character description (ECD) is for the Macquarie Marshes Nature Reserve and U-block components of the Macquarie Marshes Ramsar site. The ECD has been developed in accordance with the *National framework and guidance for describing the ecological character of Australia's Ramsar wetlands* (DEWHA 2008). A separate ECD for the Wilgara wetland was prepared in 2005 (Biosis Research 2006).

Under the Ramsar Convention, ecological character is the combination of the ecosystem components, processes and benefits/services that characterise the wetland at 'a given point in time', which is usually taken to be the time the site was listed as a Wetland of International Importance. The Macquarie Marshes Nature Reserve and U-block were both part of the Ramsar site when it was listed in 1986, which is therefore the baseline for this ECD.

The Macquarie Marshes are located on the lower floodplain of the Macquarie River in central western NSW. The Macquarie Marshes Nature Reserve and U-block are about 100 km north of Warren and 30 km west of Quambone. When listed in 1986, the site was named the Macquarie Marshes Nature Reserve Ramsar site and comprised three separate areas: a northern section and a southern section currently referred to as the northern and southern nature reserve, with a total area of 18,192 hectares; and U-block, with an area of 197.5 ha (including a road reserve). U-block is now privately owned but the road reserve through U-block will be excluded from the Ramsar site in the updated Ramsar Information Sheet (RIS).

In 2000, part of the privately owned property 'Wilgara' comprising 583 ha was added, and the Ramsar site was renamed the Macquarie Marshes Ramsar site. In 2012 the property 'Creswell', which is a recent addition to the nature reserve, was added to the Ramsar site. Altogether the Ramsar site covers about 10 per cent of the greater Macquarie Marshes.

The Macquarie Marshes are one of the largest freshwater wetlands in the Murray–Darling Basin (MDB). The ecological system contains a variety of wetland types, ranging from semi-permanent and frequently inundated marshes to ephemeral wetlands inundated by only the largest floods. Core areas of semi-permanent wetlands occur within the nature reserve. They include river red gum forests and woodlands and common reed reed beds which are fed by overbank flooding from many small channels.

The Marshes are one of the MDB's most biologically diverse wetland systems and support some of the largest waterbird breeding events in Australia (Macquarie Marshes Investigation Committee 1951; Marchant & Higgins 1990; Kingsford & Auld 2005). They provide essential breeding and feeding habitat for hundreds of species of animals and plants. Of particular value is their role in absorbing, recycling and releasing nutrients. This provides conditions suitable for some of the highest densities of microinvertebrates reported in wetlands anywhere in the world (Jenkins & Wolfenden 2006). These microinvertebrates form the basis of the food web for many larger animals.

The Marshes not only support a diverse range of plants and animals but are also an iconic natural area with significant cultural values. Many people have significant links with the Marshes through historic connections, land and water management roles, living and/or working in the vicinity or they are involved with an environmental or a primary production group. Aboriginal cultural values relate to both the deep history of Aboriginal interaction with the wetlands, and the values, interests and aspirations of contemporary Aboriginal communities with custodial relationships to the wetlands. Aboriginal cultural values relate to specific places, specific plants and animals, and also the wetlands landscape as a whole.

## **Critical components, processes and benefits/services and their limits of acceptable change**

The critical components, processes and benefits/services identified in this ECD reflect the values for which the site was Ramsar listed: expansive areas of semi-permanent wetland vegetation including river red gum forests and woodlands; common reed beds and water couch grasslands, which are dependent on frequent inundation events; large scale colonial waterbird breeding events; abundance and diversity of waterbird species; and threatened species such as the Australian painted snipe, Murray cod and superb parrot. In 2012 the Ramsar site was also recognised as meeting the Ramsar listing criterion for fish (criterion 8).

The critical components, processes, benefits and services for the nature reserve and U-block components of the Ramsar site and their requirements are summarised in Section 5 of this ECD. Information from studies carried out in the Marshes for the period between 1981 and 1991 has been used to describe the baseline condition for some of the critical components and processes including vegetation communities, waterbird breeding, geomorphology and hydrology. Limits of acceptable change (LACs) have been set in relation to extent and condition of semi-permanent wetland vegetation, floodplain wetland vegetation, the aquatic ecological community, waterbirds and waterbird breeding, and nationally threatened species. The LACs for the critical components, processes and benefits/services are described in Section 7 of this ECD.

## **Conceptual models**

Conceptual diagrams of the relationships among critical components and processes in the Macquarie Marshes during wet and dry phases explain the dynamic nature of the Marshes and are presented in Section 6. The conceptual diagrams provide a representation of the current knowledge and understanding of the Macquarie Marshes. The soils, channel morphology and flooding are identified as the key ecosystem drivers. The vegetation communities present relate to the seasonality, regularity, depth and duration of inundation, and in turn these factors provide habitats for waterbirds and fish. Inundation causes the rapid release of nutrients from the soil, the decay of plant matter, and emergence of egg and seed banks, which results in a massive pulse of aquatic biofilm and invertebrate biomass which helps to support fish and waterbird breeding in the warmer seasons.

## **Change since time of listing**

The Macquarie Marshes have existed in their current location and maintained their general wetland state for the last 6000 to 8000 years. Evidence of landscape change is available for both pre-European and post-European periods. Prior to European settlement the indigenous people of the Lower Macquarie used the Marshes. Grazing by domestic animals began in the 1830s with the establishment of cattle stations. Irrigated agriculture began in the 1840s in the South Marsh but it was not until the completion of Burrendong Dam in 1967 that large scale irrigation began. By the mid 1990s irrigated agriculture on the lower Macquarie floodplain had reached its peak both in terms of area and water use.

It is this land-use change that has led to major ecological changes. The wetlands of the Macquarie Marshes are competing for water with agricultural and urban/domestic needs. Using 1986 as the baseline condition, the nature reserve component of the Ramsar site has changed beyond acceptable limits. The most significant changes have been to the Marshes' flow regime and inundation patterns. This has led to changes in its semi-permanent wetland vegetation and the size and frequency of waterbird breeding events. In July 2009 a notification of likely change in ecological character of the Macquarie Marshes Ramsar site, principally as the result of changes to flow regime, was submitted to the Ramsar Secretariat under Article 3.2 of the Ramsar Convention.

Section 9 of this ECD establishes that actual change has taken place in the reed beds of the southern section of the nature reserve and in the river red gum forests and woodlands in the northern section of the nature reserve. The area of water couch, cumbungi and mixed marsh has also reduced to be outside the LAC set for the time of Ramsar listing, as a result of changes to the flow regime and drought conditions from 2001 to 2010.

Waterbird abundance and diversity had declined beyond the LAC by early 2010 and there had been no large scale colonial waterbird breeding events since 2000. There were two small breeding events in 2008 and 2010 and in spring–summer 2010/2011 there was a large breeding event in the Marshes, in response to a large flood event. This shows that if suitable habitat and appropriate floodplain inundation is available, large numbers of waterbirds (>20,000) and waterbird breeding events can still be supported by the Ramsar site.

It is noted that at the time of Ramsar listing in 1986, the Macquarie Marshes were already on a trajectory of change that has taken 20 years to emerge. Wetland decline in the MDB biogeographic region has been widespread. Despite this decline, in 2012 the nature reserve and U-block components of the Ramsar site still meet the Ramsar criteria for which the site was originally listed.

## **Threats**

In 2012, the Ramsar site faces the same threats it did in 1986, though exacerbated by drought between 2001 and 2010. Those threats are changes to the flow regime resulting from river regulation and water extraction, loss of connectivity due to the alteration of channels and floodplains by structures that regulate flows, drought, fire, pests and weeds. Threats are further described in Section 8 of the ECD.

## **Knowledge gaps**

There are a number of key knowledge gaps that limit the description of ecological character and the setting of limits of acceptable change for the nature reserve and U-block components of the Ramsar site. For example, there is little information about cryptic bird species such as the Australian painted snipe and whether the waterbirds using the Marshes also breed at other sites in the MDB. There is limited knowledge about the flow regime at the time of listing. There are species lists for woodland birds, but little is known of their abundance and habitat requirements. There is also inadequate knowledge about the habitat requirements of mammals, reptiles, fish and amphibians that live within the Macquarie Marshes, the interactions between species, the functional processes that support the Marshes, water quality, soil characteristics, natural versus human induced changes to geomorphology, and the interactions between fire and other ecosystem components and processes. Detailed analysis of knowledge gaps is provided in Section 11 of this ECD.

## **Monitoring**

Monitoring recommendations for the critical ecological components and processes that combine to form the ecological character of the nature reserve, are provided in Section 11 of this ECD.

Recommended monitoring for the Macquarie Marshes Ramsar site includes: flow regime characteristics (depth, duration, timing); inundation extent; extent and condition of wetland vegetation communities; waterbird abundance and diversity; waterbird breeding events; diversity and density of macro and microinvertebrates that respond to inundation; native fish diversity, abundance and recruitment; and other vertebrate fauna diversity and abundance.

## **Communication, education, participation and awareness (CEPA)**

Communication, education, participation and awareness activities can play an important role in wetland conservation, wise use and management. Actions that could be included in a CEPA plan for the Macquarie Marshes Ramsar site include:

- Advise relevant stakeholders of proposed studies, position papers, consultation and reviews to be undertaken to secure a greater understanding and ecological future for waterbird breeding sites. This includes any emerging information associated with the impacts of climate change.
- Advise government agencies and stakeholders of ecological and water requirements for wetland vegetation including river red gum forest and woodland, common reed reed beds, cumbungi and water couch marsh.
- Inform relevant landholders who are likely to be impacted by any proposed change to environmental water allocations to the Marshes.
- Consult Aboriginal people to ascertain their requirements to research, support, maintain and manage sites of significance and access to the nature reserve.
- Raise awareness of management actions that impact on the Macquarie Marshes Ramsar site through national media organisations.
- Develop and promote educational material in relation to wetlands, ecological communities, cultural heritage sites and current research findings to local, state and national media organisations, provided the information is ethically approved and in the interests of the preservation and conservation of specific sites, values and interests.



# 1 Introduction

This ecological character description (ECD) is for the Macquarie Marshes Nature Reserve and U-block components of the Macquarie Marshes Ramsar site. It collates the best available information about the ecological character of these parts of the Ramsar site when the site was listed in 1986, and changes in ecological character since that time. There is a separate ECD for the Wilgara wetland (Biosis Research 2006) with a baseline set at the year 2000.

This ECD has been prepared using the *National framework and guidance for describing the ecological character of Australia's Ramsar wetlands* (DEWHA 2008).

## 1.1 Site details

The Macquarie Marshes are located on the lower reaches of the Macquarie River in central western NSW (see Figures 1 and 2). In 1986, the Macquarie Marshes Nature Reserve Ramsar site comprised three separate areas of the wetland: a northern section (11,716 ha; includes Lots 8 and 10) and a southern section (6476.5 ha), collectively referred to as the northern and southern nature reserve and with a total area of 18,192 ha (gazetted area), and U-block with an area of 197.5 ha (gazetted area, including road reserve<sup>1</sup>). U-block is now privately owned (see Section 2.1.1). A portion of the privately owned property 'Wilgara' was added to the Ramsar site in 2000 and has an area of approximately 583 ha. In 2000, with the addition of 'Wilgara', the Ramsar site was renamed the Macquarie Marshes Ramsar site. Altogether the Ramsar area covers about 10 per cent of the greater Macquarie Marshes.

Figure 3 shows the different parts of the Ramsar site and their current tenure. Changes to the boundary occurred in 1995 with the addition of Lots 8 and 10 to the nature reserve. This change is minor with regard to the ecological character of the site and these have been included in the baseline description. 'Creswell' (688 ha gazetted area), which was gazetted by the NSW Government in 2006 as part of the nature reserve, was added to the Ramsar site in the 2012 RIS review.

The nature reserve contains a variety of wetlands, ranging from semi-permanent and frequently inundated marshes to ephemeral wetlands inundated by only the largest floods. Core areas of semi-permanent wetlands are made up of reed beds and eucalypt forests and woodlands which are fed by overbank flooding from many small channels. Core areas of semi-permanent wetland are critical for supporting waterbird and fish populations of the Macquarie Marshes at critical stages of their life cycles. U-block lies at the junction of the Old Macquarie River and Bulgeraga Creek. It also supports semi-permanent wetlands, river red gum and grassland and provides habitat for waterbirds and woodland birds. The Ramsar site is an integral part of the greater Macquarie Marshes and is dependent on the extent and condition of the greater area of the Marshes being maintained by regular floods. In this ECD, where appropriate to the Ramsar site values, information for areas beyond the Ramsar site boundary is included.

Table 1 provides concise details of the Ramsar site and further information about the compilation of this ecological character description.

---

<sup>1</sup> Note that the road reserve that runs through U-block has been excluded from this land parcel and is not included in the Ramsar site or described in this ecological character description, as it has no wetland values.

**Table 1: Site details of the Macquarie Marshes Ramsar site**

<b>Site name</b>	<b>The Macquarie Marshes</b>
<b>Location</b>	30° 45' S 147° 33' E
<b>General location</b>	The Macquarie Marshes are in central western New South Wales, southeastern Australia. The Ramsar site is comprised of the Macquarie Marshes Nature Reserve component, U-block and part of the property 'Wilgara'. The Macquarie Marshes Nature Reserve and U-block are about 100 km north of the town of Warren and 30 km west of the town of Quambone.
<b>Area</b>	In 1986 the Macquarie Marshes Nature Reserve Ramsar site consisted of a northern area of approximately 11,537 ha (excludes Lots 8 and 10 and 'Creswell'), a southern area of approximately 6476.5 ha, and U-block which had an area of approximately 197.5 ha (including the road reserve). The total area of this section of the Ramsar site was approximately 18,211 ha (gazetted area). In 2012 the site was extended to 19,850 ha.
<b>Ramsar site designation</b>	1 August 1986
<b>Ramsar criteria</b>	The Macquarie Marshes Nature Reserve and U-block together met Ramsar criteria 1 to 5 in 1986. In 2012 the site still meets these Ramsar criteria and the newly defined criterion 8.
<b>Management authority</b>	Parks and Wildlife Group, Western Branch, Office of Environment and Heritage, NSW Department of Premier and Cabinet.
<b>Status of description</b>	This is the first description of the ecological character of the Macquarie Marshes Nature Reserve and U-block components of the Macquarie Marshes Ramsar site.
<b>Date of compilation</b>	June 2012
<b>Names of compilers</b>	Jo Smith, Environmental Planner, Canberra Richard T Kingsford, Silke Nebel and Kate Brandis School of Biological, Earth & Environmental Sciences University of New South Wales, Kensington NSW 2052 email: <a href="mailto:richard.kingsford@unsw.edu.au">richard.kingsford@unsw.edu.au</a> ; <a href="mailto:silke.nebel@unsw.edu.au">silke.nebel@unsw.edu.au</a> ; <a href="mailto:kate.brandis@unsw.edu.au">kate.brandis@unsw.edu.au</a> Kerrylee Rogers and Alison Curtin, Office of Environment and Heritage Bill Johnson, Murray–Darling Basin Authority Tim Ralph, Macquarie University
<b>Ramsar Information Sheet</b>	<i>The Macquarie Marshes Ramsar Information Sheet</i> , January 2000, NSW National Parks and Wildlife Service <a href="http://www.environment.gov.au/water/topics/wetlands/database/pubs/28-ris.pdf">www.environment.gov.au/water/topics/wetlands/database/pubs/28-ris.pdf</a>
<b>Management plans</b>	<i>Macquarie Marshes Nature Reserve Plan of Management</i> (1993) NSW National Parks and Wildlife Service <i>Water Sharing Plan for the Macquarie and Cudgegong Regulated Rivers Water Source</i> 2003, NSW Government <i>Macquarie Marshes Adaptive Environmental Management Plan</i> (2010) NSW Department of Environment and Climate Change

## 1.2 Purpose of the ecological character description

The purpose of the ecological character description is twofold:

- to address obligations identified in the Convention on Wetlands of International Importance (Ramsar Convention) and the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- to provide management agencies with information about the ecological system in the Macquarie Marshes Nature Reserve and U-block component of the Ramsar site and the issues the system faces, to enable the development of mitigation strategies.

### 1.2.1 Addressing international treaty obligations and legal requirements

The Convention on Wetlands of International Importance, commonly known as the Ramsar Convention, was signed in Ramsar, Iran in 1971. The Ramsar Convention is an intergovernmental treaty with a mission for the conservation and wise use of all wetlands through local, regional and national action and international cooperation as a contribution towards achieving sustainable development throughout the world (Ramsar Convention 2002). By signing this treaty Australia has committed to designating at least one wetland that meets the criteria for inclusion in the List of Wetlands of International Importance. As of 2012 Australia has 64 wetlands listed as Ramsar sites.

The EPBC Act provides the legal basis to protect and manage internationally and nationally important flora, fauna, ecological communities, heritage places and Ramsar wetlands. Under the EPBC Act Australia is obliged to protect the ecological character of Ramsar wetlands and to manage those wetlands in accordance with Schedule 6 (Managing wetlands of international importance) of the Environment Protection and Biodiversity Conservation Regulations 2000 (Commonwealth), which states:

*The primary purpose of management of a declared Ramsar wetland must be, in accordance with the Ramsar Convention:*

- a) *to describe and maintain the ecological character of declared Ramsar wetlands in Australia*
- b) *to formulate and implement planning that promotes:*
  - i) *conservation of the wetland*
  - ii) *wise and sustainable use of the wetland for the benefit of humanity in a way that is compatible with maintenance of the natural properties of the ecosystem* (p.164, regulation 10.02).

Other key purposes for this ecological character description (mostly following McGrath 2006), are to:

1. meet Australia's obligations, by providing information as soon as the ecological character of a Ramsar listed Australian wetland has changed, is changing or is likely to change as the result of technological developments, pollution or other human interference
2. supplement the description of the ecological character in the Ramsar Information Sheet submitted under the Ramsar Convention for each listed wetland and form an official record of the ecological character of the site
3. assist the administration of the EPBC Act, in particular to:

- a) determine whether an action has, will have or is likely to have a significant impact on the ecological character of a declared Ramsar wetland in contravention of sections 16 and 17B of the EPBC Act
  - b) assess the impacts that actions referred to the Minister under Part 7 of the EPBC Act have had, will have or are likely to have on the ecological character of a declared Ramsar wetland
- 4. assist any person considering taking an action that may impact on the ecological character of a declared Ramsar wetland to decide whether to refer the action to the Minister under Part 7 of the EPBC Act for assessment and approval
- 5. inform members of the public who are interested in the Macquarie Marshes Nature Reserve and U-block components of the Ramsar Site and to consolidate current information in a publicly available document
- 6. assist the Australian and NSW Governments and community organisations in the development of management plans, policies and statutory documents for the Macquarie Marshes Nature Reserve and U-block components of the Ramsar site by providing a guide for the restoration of ecological components and processes and the restoration of resilience.

### **1.2.2 Providing information about the ecological system**

The ecological character description should provide up to date information about the ecological system in the Macquarie Marshes Nature Reserve and U-block component of the Ramsar site. The Ramsar Convention (2008) defines ecological character as the combination of components, processes, benefits and services that characterise a wetland at a given point in time.

The ecological character description should review the issues, both ecological and social, that the Ramsar site faces both in the short and long term. The ecological character description should provide management with the information required to enable the development of an environmental management plan for the site but it should not itself be a management plan.

## **1.3 Relevant treaties, legislation and policies**

In addition to being listed as a Ramsar wetland, the Macquarie Marshes Nature Reserve is listed by the National Trust of Australia (NSW) as a Landscape Conservation Area, on the Australian Heritage Commission's Register of the National Estate and in the Directory of Important Wetlands in Australia (NPWS 1993). It is also subject to local, regional, state and national policies and legislation and international bilateral migratory bird agreements (listed below).

**Table 2: Key statutory and policy instruments for delivering Ramsar obligations in NSW**

Level of application	Statutory and policy instruments	Responsibility	Other supporting instruments
International	Ramsar Convention	The Conference of the Parties to the Convention Standing Committee of the Ramsar Convention and the Ramsar Secretariat	Convention on Biological Diversity; Japan–Australia Migratory Birds Agreement; China–Australia Migratory Birds Agreement; Republic of Korea–Australia Migratory Birds Agreement; Convention on the Conservation of Migratory Species of Wild Animals; The Partnership for the East Asian–Australasian Flyway
National (Council of Australian Governments)	National Guidelines for Ramsar Wetlands – Implementing the Ramsar Convention in Australia	All jurisdictions	
National (Australian Government)	<i>Environment Protection and Biodiversity Conservation Act 1999</i>	Australian Government, led by Department of Sustainability, Environment, Water, Population and Communities (SEWPaC)	National Water Initiative including the Australian Government Water Fund; Caring for our Country program
	<i>Water Act 2007</i>	Australian Government, led by Murray–Darling Basin Authority, SEWPaC	
NSW	<i>NSW Wetlands Policy</i> (DECCW 2010b)	NSW Government, led by Office of Environment and Heritage (OEH)	<i>Water Management Act 2000</i> ; <i>Water Act 1912</i> ; State Water Management Outcomes Plan (2003); <i>Threatened Species Conservation Act 1995</i> ; <i>Fisheries Management Act 1994</i> ; <i>Environmental Planning and Assessment Act 1979</i> ; Draft Floodplain Harvesting Policy; voluntary conservation agreements; wildlife refuges
	NSW Wetland Recovery Program (2005)	NSW Government, led by OEH	
	NSW Rivers Environmental Restoration Program including Riverbank (2007)		
	<i>NSW Ramsar Plan 2006–09</i> (DEC 2006)		
Macquarie Marshes Ramsar site	Water Sharing Plan for the Macquarie and Cudgegong Regulated Rivers Water Source 2003	NSW Government, led by Office of Water	<i>National Parks and Wildlife Act 1974</i>
	Regional Investment Strategy and Catchment Action Plan	Central West Catchment Management Authority	
	<i>Macquarie Marshes Nature Reserve Management Plan</i> (NPWS 1993)	NSW Government, led by OEH	

## 2 Macquarie Marshes Ramsar site

### 2.1 Location

The greater Macquarie Marshes cover an area of approximately 200,000 ha (NPWS 1993) of the floodplain of the lower Macquarie River in central western NSW. The Macquarie River is a large regulated river in the MDB, with a catchment of about 75,000 km<sup>2</sup> (Figure 1). The river rises on the western side of the Great Dividing Range, southeast of Bathurst, and extends about 800 km northwest before joining the Barwon–Darling River. As the Macquarie flows onto the Darling Riverine Plain, downstream of Narromine, it develops distributary streams and forms extensive floodplain wetlands. These streams flow north and northwest to join the Bogan and Barwon–Darling Rivers. The main Macquarie River channel continues north, becoming discontinuous and forming the Macquarie Marshes about 30 km north of Warren. The Marshes extend for about 120 km northwards before the river reforms near Carinda and discharges to the Barwon River between Walgett and Brewarrina (Johnson 2005; Figure 2).

The Macquarie Marshes Nature Reserve and U-block are about 100 km north of Warren and 30 km west of Quambone. The boundary for the Macquarie Marshes Nature Reserve component of the Ramsar site is the nature reserve boundary as gazetted 22 January 1971 including additions (Lots 8 and 10) gazetted 17 February 1995 (179 ha) and added to the Ramsar site via an updated RIS in 1998. The gazetted area of the nature reserve in 1995 was 18,143 ha. The boundary of U-block is the cadastral boundary of Lot 47, DP72721 and has a surveyed area of 189 ha, excluding the road reserve (Figure 3).

#### 2.1.1 Land tenure

In January 1971 the Macquarie Marshes Nature Reserve was dedicated under the *National Parks and Wildlife Act 1967* (NSW) covering the area of Crown Land which was originally reserved in 1900 for the preservation of game. In 1919 this area had been committed as a bird and animal sanctuary; in 1943 as a reserve for the preservation of native fauna, and in 1955, as a fauna protection district. At the time of this publication the nature reserve is owned and managed by the Office of Environment and Heritage (OEH) under the *National Parks and Wildlife Act 1974*. All other areas within the Macquarie Marshes (including U-block and the ‘Wilgara’ components of the Ramsar Site) are either privately owned or leased.

In 1989, under Part 4 of the *National Parks and Wildlife Act 1974*, U-block (197.5 ha including road reserve) was revoked from the Macquarie Marshes Nature Reserve by an Act of Parliament. U-block was exchanged for 179 ha of land adjacent to the northern nature reserve known as Hall’s block, being Lot 10 in DP727217 and Lot 8 in DP751622. In February 1995, this land was dedicated as part of the Macquarie Marshes Nature Reserve.

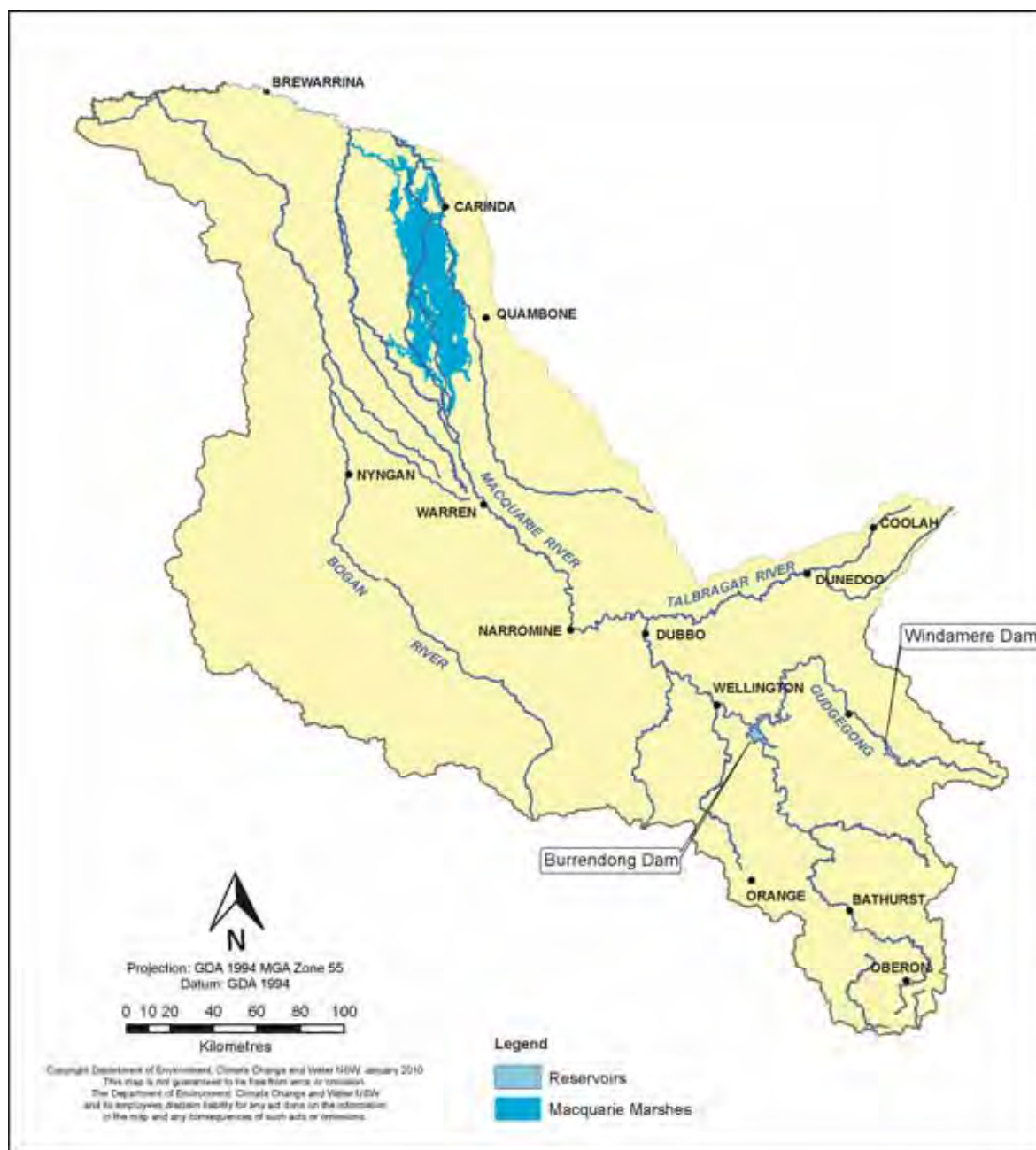
In January 1998, when the Ramsar Information Sheet (RIS) was updated for the Macquarie Marshes Nature Reserve Ramsar site, the Ramsar boundary map was adjusted to show the new boundary of the nature reserve, removing U-block and adding Hall’s block.

In 2012 it is acknowledged that U-block should still be part of the Macquarie Marshes Ramsar site, as designated in 1986 and the RIS has been updated in accordance with Resolution VIII.21 Clause 9A of the Ramsar Convention – *the site boundary has been drawn incorrectly and there has been a genuine error*. U-block is now private freehold land and is managed as a grazing property. The road reserve (Warren–Carinda road) that runs through U-block and was included in the original nature reserve Ramsar listing was not added back into the Ramsar site as it has no wetland values.

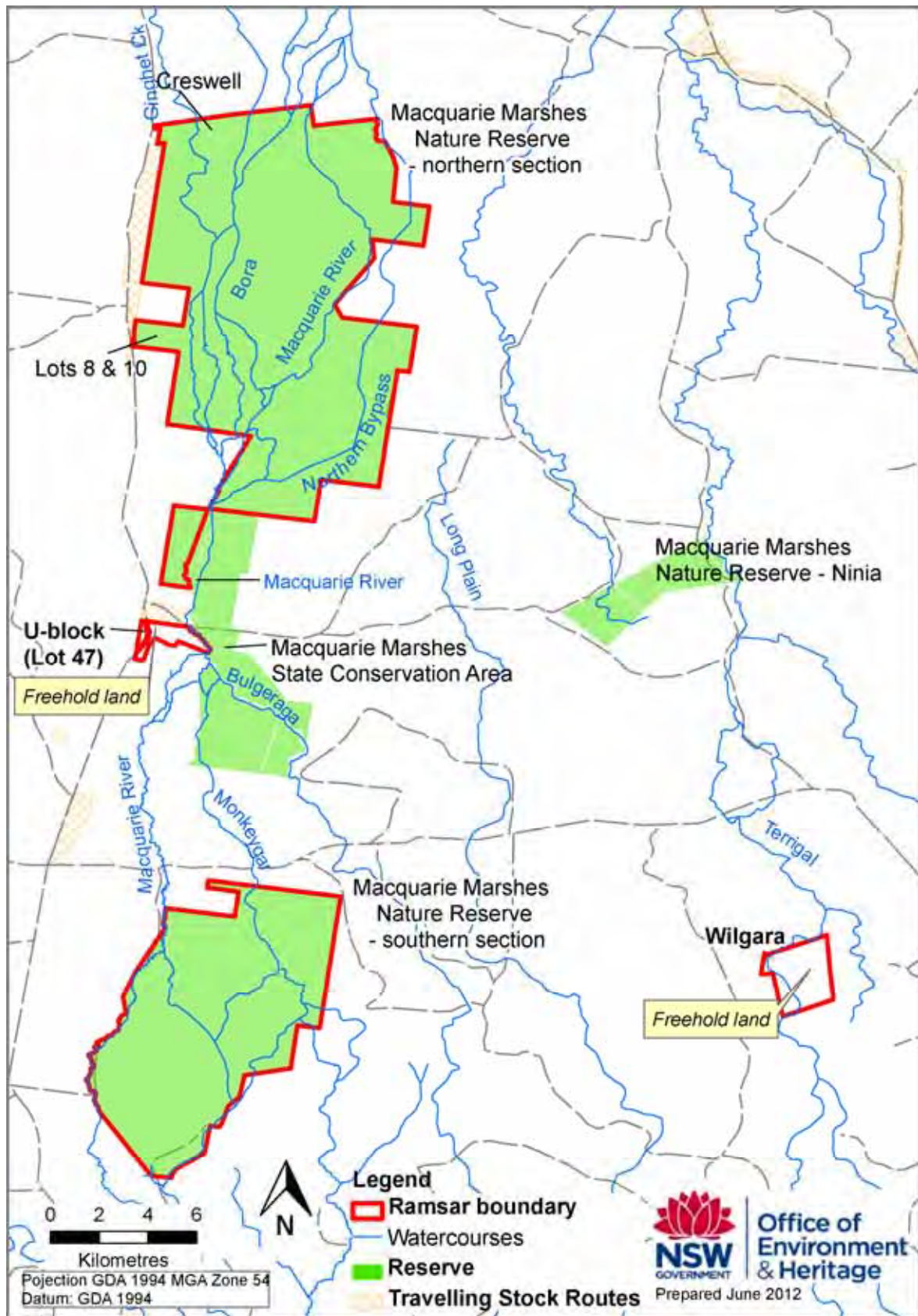




**Figure 1: Location of the Macquarie River Catchment in the MDB**



**Figure 2: The Macquarie River catchment and the Macquarie Marshes**



**Figure 3: Macquarie Marshes Ramsar site showing the different parts of the Ramsar site – northern nature reserve, southern nature reserve, U-block component and ‘Wilgara’ component, and their respective tenures**

### 2.1.2 History of land and water use in the Macquarie valley

Changes in land and water use and management in the Macquarie valley have greatly influenced the extent and health of the Macquarie Marshes. The Macquarie Marshes have existed in their current location and maintained their general wetland state for the last 6000 to 8000 years (Yonge & Hesse 2002). Prior to European settlement the indigenous people of the Lower Macquarie used the Marshes (Peckham & Molsher 2005). Grazing by domestic animals and the establishment of cattle stations began in the 1830s and this land use continues. Irrigated agriculture began not long after European settlement in the 1840s in the South Marsh however it was not until the completion of Burrendong Dam in 1967 that large scale irrigation began. By the mid 1990s irrigated agriculture on the lower Macquarie floodplain had reached its peak both in terms of area and water use (MRAC 1994).

Despite concerns about the impacts of Burrendong Dam on the environment of the Marshes, government and community support for irrigation resulted in the approval of construction of the dam in 1946. In 1951 the Macquarie Marshes Investigation Committee (MMIC) suggested that the Marshes should have a primary right to regulated flow from the dam and that water should be supplied to irrigation only after the needs of the Marshes had been met (Johnson 2005) and in 1962 it was announced that 40,000 acre feet (about 50,000 ML) would be set aside annually for the Marshes (National Trust 1985, cited in Johnson 2005).

In 1967, when the dam was about half full, a 'special release' was made from Burrendong Dam (WC&IC 1968), in response to Lower Macquarie landholders experiencing dry conditions. These conditions were exacerbated by the dam and irrigation had not yet been developed to a stage where the dam's water could be used (WC&IC 1968; Sinclair Knight & Partners 1984). In the same year, the Water Conservation and Irrigation Commission (WCIC) also made a commitment to supply a reduced volume of approximately 15,000 acre feet (or 18,500 ML) to the Marshes if required (WC&IC 1968).

The development of irrigation schemes involved the clearing and levelling of land, construction of channel systems and installation of pumps. In many cases levees to protect crops from floodwaters were also constructed. Other interventions ranged from small dams erected by farmers and graziers to give their property a more permanent water supply, through to major interventions such as dam and weir construction by government (Masman & Johnstone 2000).

Six major 'off-river' irrigation schemes were established between 1966 and 1975 (Kingsford 2000). These were: Nevertire Scheme (1966), Buddah Lake Scheme (1969), Greenhide Scheme (1970), Narromine–Trangie Scheme (1971), Trangie–Nevertire Scheme (1973), and the Tenandra Scheme (1975).

Development guidelines produced by the Water Resources Commission (WRC) in the late 1970s and early 1980s identified the floodplain between Narromine and Warren as the best land in the valley for irrigation, with flooding and extensive wetlands deemed the only disadvantage (WRC undated a & b, as cited in Johnson 2005). Up until 1979, most irrigation in the Macquarie Valley was based on an individual entitlement to irrigate 162 hectares of land, although the volume of water that could be applied to the land was not specified (Sinclair Knight & Partners 1984). Entitlements to a set volume of water were introduced in 1979 (WRC 1979). The areas being developed for irrigation grew rapidly, more than doubling from the mid 1980s to the mid 1990s, resulting in large areas of the natural floodplain becoming isolated from the river. A floodplain management plan identifies numerous structures that would require modification to optimise the functionality of floodways between Narromine and Oxley Station, to protect property and to improve and maintain the diversity and well-being of riverine and floodplain ecosystems that depend on flood inundation (DECC 2008).



In the late 1960s the WC&IC announced plans to deliver water through the Macquarie Marshes to supply regulated flow for irrigation downstream near Carinda, to compensate for loss of natural flooding in the area (Brereton 1993; Johnson 2005). The allocation of regulated flows to service this irrigation development was subject to the construction of works to convey flows through the Macquarie Marshes 'efficiently' (Brereton 1993). The first stage of the Macquarie Marshes bypass works, including regulators and an 18 kilometre channel, was constructed through the North Marsh in 1973.

After the completion of Burrendong Dam the total annual regulated yield of the Macquarie River was assessed as 406,000 ML in a normal year (Sinclair Knight & Partners 1984). By 1978 the Macquarie River Advisory Committee (MRAC), a group consisting mostly of members of the irrigation industry established by the government to advise on river management, believed that water from the river was over-committed. It was MRAC policy that the issuing of all licences and authorities should be suspended (MRAC 1978).

In 1979 the WRC placed an embargo on applications for licences, and increased the estimated annual regulated yield of the river to 475,000 ML (Sinclair Knight & Partners 1984; WRC 1981). However, the embargo did not halt the growth in water allocations in the Macquarie system. By that time allocations for extraction had risen to 497,500 ML, an over-commitment of 22,500 ML (WRC 1981; Johnson 2005).

By the mid-1980s, prior to the Macquarie Marshes Nature Reserve being Ramsar listed, the river was over-committed by 137,000 ML/year. These estimates did not include access to unregulated river flows ('off allocation' or 'supplementary' flow). Allocations to existing licence holders were increased by about 130,000 ML in 1985 (WRC 1985), despite concerns and objections from other landholders, government agencies and conservation groups. This exacerbated the previously identified problem of over-allocation of water (MRAC 1978; WRC 1981; WRC 1985b, as cited in Johnson 2005).

Since 1985 allocations have continued to rise without an increase in the 475,000 ML of assessed regulated flow. In 2005 the allocation to extractive use in the Macquarie and Cudgegong rivers was 738,793 ML/year. With the addition of 160,000 ML allocated to the environment, the total surface water allocation from regulated and supplementary flow was 898,793 ML (NSW Government 2003), almost twice the river's revised estimated yield of 475,000 ML (Johnson 2005).

## **2.2 Ramsar criteria**

### **2.2.1 Criteria under which the site was designated**

When originally listed as the Macquarie Marshes Nature Reserve Ramsar site in 1986, the site was recognised as internationally important according to the pre-1999 Ramsar criteria 1a, 2b and 3. In 1998, when the RIS was updated, the site was regarded as also meeting criteria 1c, 1d, 2c, 3a and 3b. These criteria equate to the current 2005 Ramsar criteria 1, 2, 3, 4 and 5 (RIS 2000).

### **2.2.2 Assessment based on current information and Ramsar criteria**

There have been changes to the way criteria are applied since the site was listed in 1986 and the RIS last updated in 2000, which influence the application of the Ramsar criteria, including:

- Refinements and revisions of the Ramsar criteria have been made and 7<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> criteria have been added.
- The one per cent population thresholds for birds have been revised (Li & Mundkur 2007; Bamford et al. 2008), which influences the application of criterion 6.

- The bioregionalisation for inland aquatic systems for the implementation of the Ramsar Convention in Australia has changed from IBRA to Australian Drainage Divisions. This affects the application of criteria 1 and 3.
- Threatened species listings have been updated, and there is a focus on nationally and internationally threatened species, which affects criterion 2.

In 2012, all the criteria met at listing are still considered to be met. Criterion 8 is also considered to be met and would likely also have been met at the time of listing had it been assessed. An explanation of how the then Macquarie Marshes Nature Reserve Ramsar site (including U-block) met each criterion at the time of listing (1986) is provided below. This is based on the 2000 RIS update and new information regarding the fish criterion.

**Criterion 1: Contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.**

The greater Macquarie Marshes were in 1986 and remain one of the largest freshwater wetlands in the MDB. They are a representative example of an inland floodplain wetland of the MDB as they rely on water from a higher rainfall upper catchment and have extensive and changeable wetlands in their semi-arid lowland reaches. They are unique within the MDB in terms of their size and diversity of wetland types (Mussared 1997), and the extent of particular wetland communities. It is estimated that the MDB has over 30,000 wetlands, but the greater Macquarie Marshes is one of only four wetlands that cover an area of 200,000 ha or more (Crabb 1997).

The main wetland communities in the Ramsar site exist as a mosaic and include common reed reed beds, water couch marsh and mixed marsh, lignum shrublands, river red gum forests and woodlands, coolibah woodlands and open water lagoons. The river red gum forest and woodlands, common reed reed beds and water couch marsh are rare examples of these wetland types in the MDB. The extent of these communities is a key feature of the site. In the MDB, it is one of three sites of extensive river red gum (*Eucalyptus camaldulensis*) woodland, one of two sites supporting extensive common reed (*Phragmites australis*) reed beds, and one of two sites with extensive water couch (*Paspalum distichum*) marsh. These communities support significant wetland species diversity including colonial nesting waterbirds, migratory shorebirds, frogs, fish and reptiles (Mussared 1997). The Macquarie Marshes Nature Reserve component of the Ramsar site has supported some of the largest colonial nesting waterbird breeding events in Australian history (Macquarie Marshes Investigation Committee 1951; Marchant & Higgins 1990; Kingsford & Johnson 1998; Kingsford & Auld 2005).

**Criterion 2: Supports vulnerable, endangered, or critically endangered species or threatened ecological communities.**

According to the 2000 RIS, the Macquarie Marshes supported at least four species listed as endangered or vulnerable under the NSW *Threatened Species Conservation Act 1995* (TSC Act): Australasian bittern, brolga, magpie goose and aromatic peppercreep. Current EPBC Act listings were not available and therefore were not considered at that time.

It is now known that the Macquarie Marshes Nature Reserve component of the Ramsar site supports at least 35 threatened species (Table 3). Of these species, four are internationally listed as endangered or vulnerable (IUCN Red List, IUCN 2011), five are nationally listed as endangered or vulnerable (EPBC Act) and 34 are listed in NSW as endangered or vulnerable (TSC Act, *Fisheries Management Act 1994*). The Macquarie Marshes Nature Reserve also supports two endangered ecological communities: Coolibah-black box woodland of the northern riverine plains in the Darling Riverine Plains and Brigalow Belt South bioregions (TSC Act) and the aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River (NSW *Fisheries Management Act 1994*).



**Table 3: Threatened flora and fauna species in the Macquarie Marshes Nature Reserve  
(E = Endangered, V = Vulnerable, NT = Near-threatened, LC = Least concern)**

Common name	Scientific name	IUCN Red List 2011	EPBC Act (Cth)	TSC Act (NSW)	FM Act 1994 (NSW)
Stripe-faced dunnart	<i>Sminthopsis macroura</i>	LC		V	
Squirrel glider	<i>Petaurus norfolcensis</i>	LC		V	
Yellow-bellied sheath-tail bat	<i>Saccolaimus flaviventris</i>	LC		V	
Eastern freetail bat	<i>Mormopterus norfolkensis</i>	LC		V	
Little pied bat	<i>Chalinolobus picatus</i>	LC		V	
Osprey	<i>Pandion haliaetus</i>	LC		V	
Square-tailed kite	<i>Lophoictinia isura</i>	LC		V	
Black-breasted buzzard	<i>Hamirostra melanosternon</i>	LC		V	
Australian bustard	<i>Ardeotis australis</i>	NT		E	
Australasian bittern	<i>Botaurus poiciloptilus</i>	E	E	V	
Black-necked stork	<i>Ephippiorhynchus asiaticus</i>	NT		E	
Magpie goose	<i>Anseranas semipalmata</i>	LC		V	
Freckled duck	<i>Stictonetta naevosa</i>	LC		V	
Cotton pygmy goose	<i>Nettapus coromandelianus</i>	LC		E	
Blue-billed duck	<i>Oxyura australis</i>	NT		V	
Brolga	<i>Grus rubicundus</i>	LC		V	
Bush stone-curlew	<i>Burhinus grallarius</i>	NT		E	
Australian painted snipe	<i>Rostratula australis</i>	LC	V	V	
Black-tailed godwit	<i>Limosa limosa</i>	NT		V	
Red-backed button-quail	<i>Turnix maculosa</i>	LC		V	
Major Mitchell's cockatoo	<i>Cacatua leadbeateri</i>	LC		V	
Red-tailed black-cockatoo	<i>Calyptorhynchus banksii</i>	LC		V	
Glossy black-cockatoo	<i>Calyptorhynchus lathami</i>	LC		V	
Turquoise parrot	<i>Neophema pulchella</i>	LC		V	
Superb parrot	<i>Polytelis swainsonii</i>	V	V	V	
Barking owl	<i>Ninox connivens</i>	LC		V	
Hooded robin	<i>Melanodryas cucullata</i>	LC		V	
Grey-crowned babbler	<i>Pomatostomus temporalis</i>	LC		V	
Brown treecreeper	<i>Climacteris picumnus</i>	LC		V	
Painted honeyeater	<i>Grantiella picta</i>	NT		V	
Black-chinned honeyeater	<i>Melithreptus gularis gularis</i>	V		V	
Diamond firetail	<i>Stagonopleura guttata</i>	NT		V	
Silver perch	<i>Bidyanus bidyanus</i>	V			V
Murray cod	<i>Maccullochella peelii peelii</i>		V		
Aromatic peppergrass	<i>Lepidium hyssopifolia</i>		E	E	

**Criterion 3: Supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.**

Within the MDB the Macquarie Marshes Nature Reserve component of the Ramsar site supports one of only three extensive river red gum (*Eucalyptus camaldulensis*) woodlands (approx. 6000 ha), the other two being in the southern half of the MDB on the Murrumbidgee and Murray rivers. These woodlands in the Macquarie Marshes Nature Reserve provide nesting sites and habitat for both waterbirds and woodland birds.

The Macquarie Marshes is also one of only two sites in the MDB (the other being the Great Cumbung swamp) supporting extensive common reed (*Phragmites australis*) reed beds. In 1991 the Macquarie Marshes Nature Reserve supported approximately 3300 ha of common reed in two main reed beds, one in the northern and one in the southern section of the nature reserve (Wilson 1992).

The Macquarie Marshes is also one of only two sites in the MDB (the other being the Gwydir Wetlands) with extensive water couch (*Paspalum distichum*) marsh (approx. 4500 ha). There were 1128 ha of water couch in the Ramsar site's original extent (northern and southern nature reserve) when the Marshes' vegetation was mapped in 1991 (Bowen & Simpson 2010). Most of the remaining water couch occurs on private land outside the nature reserve. It is found within the 'Wilgara' wetland and U-block components of the Ramsar site (Bowen & Simpson 2010).

These wetland vegetation communities provide habitat for 77 waterbird species and 15 frog species, as well as many other birds, mammals and reptiles (Appendix 2).

**Criterion 4: Supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.**

The Ramsar wetlands represent highly significant habitat for colonial nesting waterbirds. They are one of the few sites supporting large breeding colonies of straw-necked ibis (*Threskiornis spinicollis*) in Australia and one of only a few sites in NSW where the magpie goose breeds (Kingsford & Thomas 1995). They also support some of the largest breeding colonies of intermediate egret (*Ardea intermedia*), rufous night heron (*Nycticorax caledonicus*) and royal spoonbill (*Platalea regia*) in southern Australia, as well as a rich diversity of other waterbirds including cormorants, herons, spoonbills and ducks, many of which breed there.

In a catchment that has been modified by agricultural activities, these remaining wetlands have become a regionally important refuge for wildlife. They represent an important drought refuge during periods when many other inland wetlands have dried out. The Ramsar site provides important habitat for 17 species of migratory birds covered under the Japan–Australia, China–Australia and South Korea–Australia Migratory Bird Agreements (JAMBA, CAMBA and ROKAMBA). These are the white-bellied sea-eagle (*Haliaeetus leucogaster*), cattle egret (*Ardea ibis*), great egret (*Ardea alba*), caspian tern (*Sterna caspia*), bar-tailed godwit (*Limosa lapponica*), black-tailed godwit (*Limosa limosa*), common greenshank (*Tringa nebularia*), common sandpiper (*Actitis hypoleucos*), curlew sandpiper (*Calidris ferruginea*), Latham's snipe (*Gallinago hardwickii*), marsh sandpiper (*Tringa stagnatilis*), red-necked stint (*Calidris ruficollis*), sharp-tailed sandpiper (*Calidris acuminata*), wood sandpiper (*Tringa glareola*), glossy ibis (*Plegadis falcinellus*), fork-tailed swift (*Apus pacificus*) and white-throated needletail (*Hirundapus caudacutus*).

**Criterion 5: Regularly supports 20,000 or more waterbirds.**

The justification against criterion 5 provided in the 2000 RIS was inadequate and data has been re-analysed to determine whether this criterion was met at the time of listing.

According to the Convention guidance on designating Ramsar sites, 'a wetland *regularly* supports a population of a given size if:

- i) the requisite number of birds is known to have occurred in two thirds of the seasons for which adequate data are available, the total number of seasons being not less than three; or
- ii) the mean of the maxima of those seasons in which the site is internationally important, taken over at least five years, amounts to the required level (means based on three or four years may be quoted in provisional assessments only).'

The guidance also says that, in establishing the long-term use of a site by birds, '...natural variability in population levels should be considered especially in relation to the ecological needs of the populations present. Thus in some situations [e.g. wetlands in arid and semi-arid areas] ...the simple arithmetical average number of birds using a site over several years may not adequately reflect the true ecological importance of the site... In such situations, there is a need for interpretation of data from an appropriate time period in order to ensure that the importance of sites is accurately assessed.'

The 2000 RIS states that the wetlands of the Macquarie Marshes regularly supported more than 20,000 waterbirds and over 500,000 in large floods. While there are no records of the total numbers of waterbirds using the Macquarie Marshes Ramsar site over time, it is possible to estimate numbers using available information about the location of nesting sites and the habitat requirements of waterbirds, historical data on water inflows to the Marshes and a model of the relationship between inflows and waterbird breeding events.

Sixteen colonial nesting waterbird species have been recorded breeding in the greater Macquarie Marshes. Species in the greatest numbers are the great egret, intermediate egret, little egret, nankeen night heron, glossy ibis, Australian white ibis, straw-necked ibis, little pied cormorant and little black cormorant (Kingsford & Thomas 1995; Kingsford & Auld 2005). Of the 15 known breeding sites in the Macquarie Marshes, six are within the nature reserve and one in the 'Wilgara' part of the Ramsar site. It is therefore assumed that the Ramsar site supports about 50 per cent of colonial nesting waterbirds that breed in the Marshes.

Kingsford and Auld (2003) demonstrated that the nesting of large numbers of colonial waterbirds (specifically ibis, egret, cormorant and night herons) was correlated with flows of more than 200,000 ML at Oxley gauge, which is upstream of the Marshes. These wetland inflows result in inundation of sufficient nesting and feeding habitat for long enough to allow breeding to be completed successfully.

Up to the year 2000, it is probable that the Macquarie Marshes Ramsar site supported more than 20,000 waterbirds in at least two-thirds of the seasons when inflows were large enough to provide suitable breeding conditions. In this period there were seven years where flow volumes exceeded 200,000 ML at Oxley gauge (1988, 1989, 1990, 1993, 1996, 1998 and 2000). Nest counts for colonies within the Ramsar site for these years were 2600, 6200, 37,500, 9300, 2700, 23,800 and 29,100. If the number of nests is used to estimate waterbird numbers (two adults per nest plus chicks), then it is highly likely that 20,000 colonial waterbirds were supported by the Ramsar site in at least five of these years – 1989, 1990, 1993, 1998 and 2000 (Kingsford & Auld 2003).

Other species such as ducks, geese, grebes and shorebirds are also present in high numbers when the Marshes are inundated (Eastern Australian Aerial Waterbird survey), but there is no available estimate of their total numbers in the Ramsar site.

**Criterion 8: Is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.**

Due to the location of the Macquarie Marshes in the lower end of the Macquarie catchment, its fish community is a blend of those found in adjacent main channel habitats.

That is, directly upstream and downstream, but also in adjacent systems such as Marthaguy Creek. During high flows, fish are likely to move into the Marshes from these areas (King 2004; Jenkins & Wolfenden 2006). More specifically, the composition (richness, relative abundance and biomass) of a fish community found at a particular site or within a particular creek in the Marshes is likely to be regulated by a combination of local habitat characteristics, recent and historical flows and the degree of longitudinal and lateral connectivity to habitats, including the floodplain (Jenkins et al. 2004).

All native fish species in the Macquarie Marshes and lower Macquarie River typically recruit during spring and early summer. During this critical time appropriate flows are needed to induce spawning, protect eggs and promote larval and juvenile fish survival. Warmer temperatures during this period are important for most species. Appropriate (seasonal) flows are needed during these critical larval rearing stages to prevent wash out of larvae and prey from nursery habitats (Humphries et al. 2002). Restoration of late winter–spring floods would provide optimal feeding and growth conditions for adult fish before spawning (Humphries et al. 2002), as well as providing floodplain habitats with a rich supply of food for larval and juvenile fish (Gehrke et al. 1995).

The Macquarie Marshes support a significant life history stage as recent evidence suggests that native fish move out of the main channel habitats into the floodplain to breed and spawn with the onset of high flows (Balcombe et al. 2007). It is also possible that some species may breed within the main channel during smaller flow events if conditions are right (Humphries et al. 1999).

## **2.3 Macquarie Marshes Nature Reserve wetland types in 1986**

The Macquarie Marshes Nature Reserve and U-block contain a variety of wetlands, ranging from semi-permanent and frequently inundated marshes to ephemeral wetlands inundated by only the largest floods. Core areas of semi-permanent wetlands are made up of reed beds and riparian eucalypt woodlands which are fed by overbank and overland flooding from many small channels.

The Macquarie Marshes are best described as intermittent freshwater marshes (Ts) under the Ramsar Convention, although there are also areas dominated by open water, shrubs and trees. In the 2000 RIS, the Macquarie Marshes Ramsar site was classified as supporting six Ramsar wetland types – N, P, Xf, Ts, W and Tp. However, there are no freshwater lakes greater than 8 ha (P) or permanent freshwater marshes or pools (Tp). Based on mapping done by Wilson (1992) and its analysis using GIS software by Bowen and Simpson (2010), the Ramsar site at the time of listing should be described as supporting the Ramsar wetland types – Ts, Xf, N and W as defined in Table 4.

There has been no specific fine scale wetland mapping in the Macquarie Marshes but there are several vegetation community classifications which provide the basis for wetland types (Paijmans 1981, Wilson 1992, Bowen & Simpson 2010). Figure 4 shows the main wetland types in the Macquarie Marshes Nature Reserve and surrounds in 1981, mapped by Paijmans prior to Ramsar listing.

The wetland types found in the Macquarie Marshes Nature Reserve and U-block are listed in Table 5. The approximate areas listed are from vegetation mapping in 1991 (Wilson 1992). The combination of Paijman's 1981 mapping and Wilson's 1991 mapping is the best estimate of wetland types that existed in 1986 at the time of Ramsar listing (Wilson 1992).

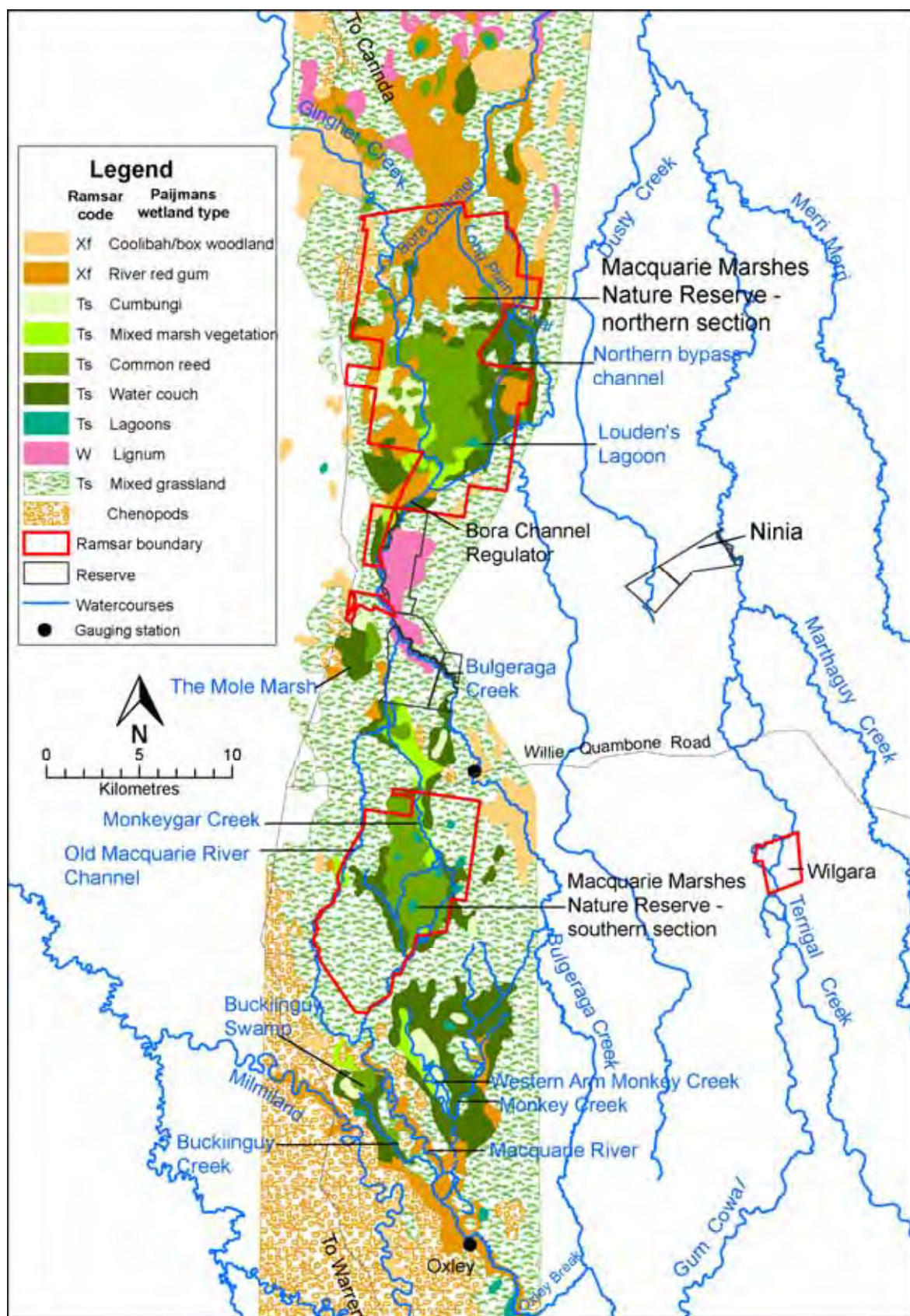
**Table 4: Ramsar wetland types found in the Macquarie Marshes Nature Reserve in 1986**

Ramsar description	Examples from Macquarie Marshes Ramsar site	Wetland type code
Seasonal/intermittent freshwater marshes/pools on inorganic soils; includes sloughs, potholes, seasonally flooded meadows, sedge marshes	Freshwater lagoons, common reed swamps, water couch grasslands, marsh club-rush sedgeland	Ts
Freshwater tree-dominated wetlands; includes freshwater swamp forests, seasonally flooded forests, wooded swamps on inorganic soil	River red gum forest and woodland, coolibah woodlands, black box woodlands	Xf
Seasonal/intermittent/irregular rivers/streams/creeks/ channels	Macquarie River, Bora channel, Ginghet Creek, Monkeygar Creek	N
Shrub-dominated wetlands; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils	Lignum shrubland occurs in the northern nature reserve (Salt paddock and a small area in Q-block and in Halls block	W



**Photograph 1: Common reed reedbed in the northern section of the Macquarie Marshes Nature Reserve (Photo: Tim Ralph, 2010)**





**Figure 4: Main wetland types in the Macquarie Marshes Nature Reserve and surrounds in 1981 mapped by Paijmans**



**Table 5: Wetland types, locations and area in Macquarie Marshes Nature Reserve around the time of Ramsar listing**

<b>Wetland type (Ramsar type)</b>	<b>Location</b>	<b>Approx. area (ha) in 1991<sup>#</sup></b>
<b>River red gum forest and woodland (Xf)</b>	Bora Channel (northern section of the Macquarie Marshes Nature Reserve) – extends into adjacent private land	4000
	Macquarie Channel (northern section of the Macquarie Marshes Nature Reserve) – extends into adjacent private land	2000
	Hunt's Woodland (northern section of the Macquarie Marshes Nature Reserve) – extends into adjacent private land	100
	Southern section of the Macquarie Marshes Nature Reserve	210
	U-block	85
<b>Coolibah and/or black box woodland (Xf)</b>	Northern section of the Macquarie Marshes Nature Reserve	600
	Southern section of the Macquarie Marshes Nature Reserve	100
	U-block	20
<b>Common reed reed beds (Ts)</b>	Louden's Lagoon and northern section of the Macquarie Marshes Nature Reserve	2150
	Southern section of the Macquarie Marshes Nature Reserve	1200
<b>Cumbungi rushland (Ts)</b>	Bora Channel (northern section of the Macquarie Marshes Nature Reserve)	260
<b>Water couch marsh (Ts)</b>	Louden's Lagoon and northern section of Macquarie Marshes Nature Reserve	910
	Southern section of the Macquarie Marshes Nature Reserve	220
<b>Mixed marsh grassland (Ts)</b>	U-block	50
<b>Open water lagoons (Ts)</b>	Louden's Lagoon (northern section of the Macquarie Marshes Nature Reserve)	60
	Southern section of the Macquarie Marshes Nature Reserve	30
<b>Lignum (W)</b>	Northern section of the Macquarie Marshes Nature Reserve including Salt paddock, Q-block and Halls block	Not mapped but less than 200 ha
<b>Seasonal/intermittent/irregular rivers/streams/creeks (N)</b>	Macquarie River, Bora Channel, Monkeygar Creek, Ginghet Creek	–

<sup>#</sup> Approximate areas of vegetation communities, reflecting Ramsar wetland types from Bowen and Simpson 2010